- 1 -

COMMUNICATION UNIT, COMMUNICATION SYSTEM AND METHOD FOR REDUCING NETWORK CONGESTION THEREIN

Field of the Invention

5

This invention relates to a mechanism for reducing network congestion in a communication system. The invention is applicable to, but not limited to, a mechanism for wireless subscriber units to self regulate

10 their operation in order to reduce network congestion in a cellular communication system.

Background of the Invention

15 Wireless communication systems, for example cellular telephony or private mobile radio communication systems, typically provide for radio telecommunication links to be arranged between a plurality of base transceiver stations (BTSs) and a plurality of subscriber units, often termed

20 mobile stations (MSs).

In a wireless communication system, each BTS has associated with it a particular geographical coverage area. Transmitter power levels and receiver sensitivity

25 performance define the coverage area where the BTS can maintain acceptable communications with MSs. Typically, coverage areas are configured as overlapping areas to facilitate continuous communication as MS move between the areas. The coverage areas are generally termed

30 cells, which can combine to produce an extensive coverage area of the communication system, for example to provide countrywide coverage.

- 2 -

Wireless communication systems are distinguished over
fixed communication systems, such as the public switched
telephone network (PSTN), principally in that mobile
stations move between coverage areas served by different
5   BTS (and/or different service providers) and, in doing
so, encounter varying radio propagation environments.
Therefore, in a wireless communication system, MSs
perform handover operations, when moving between
different geographical areas/cells. In this manner, the
10 MSs can be supported in their communications by the
nearest BTS, which typically offers the highest quality
signal/communication link. Each BTS is connected to a
Base Site Controller (BSC), which together form a Base
Switching Site (BSS).
15

An established harmonised cellular radio communication
system, providing predominantly speech and short data
messaging communication, is the Global System for Mobile
Communications (GSM). An enhancement to this cellular
20 technology has been developed, termed the General Packet
Radio System (GPRS). GPRS provides packet switched
technology on GSM's switched-circuit cellular platform.

A fixed network interconnects all BTSs, through
25 respective BSCs. This fixed network comprises
communication lines, switches, interfaces to other
communication networks and various controllers required
for operating the network. A call from a MS is routed
through the fixed network to the destination node or
30 communication unit identified by the call. If the call
is between two MSs of the same communication system the
call will be routed through the fixed network to the BTS
of the cell in which the other MS is currently located.

- 3 -

A connection is thus established between the two serving
cells through the fixed network. Alternatively, if the
call is between a MS and a telephone connected to the
Public Switched Telephone Network (PSTN) the call is
5   routed from the serving BTS to the interface between the
cellular mobile communication system and the PSTN. It is
then routed from the interface to the telephone by the
PSTN.

10 In the field of communication systems, it is known that
particular events can place a telecommunication system
under increased network load, causing failure of
communication links. For example, it is known that
'events' such as faults, emergencies, advertising
15 campaigns, televised telephone hotlines, etc., can result
in a large number of call attempts to a particular number
or set of numbers, which increases network load.

This scenario is illustrated in the wireless
20 communication system 100 of FIG. 1. A number of wireless
subscriber units 110 attempt to contact a particular
telephone number, for example telephone number 'X' 160.
Hence, the air-interface resource is heavily utilised to
carry the wireless transmissions 115 to the subscriber
25 unit's respective BSSs 120. The fixed network
connections 125 between the wireless BTSs and the
wireless exchange 130 also become heavily loaded. All of
these calls are then routed through the core network 140
to a destination exchange 150. Generally, a limited
30 number of telephone lines are utilised by destination
unit 'X' 160 to receive these calls from the destination
exchange 150. Therefore, a vast number of the incoming

- 4 -

calls take up valuable resources, but are ultimately
rejected by the destination exchange 150.

It is known, in extreme circumstances, that the target
5 telephone exchange 150 may fail under the load of
refusing a large number of incoming call attempts. This
is a serious problem and network operators maintain staff
to take preventative action on such occurrences.

10 A known technique commonly used to solve this problem in
fixed communication networks is termed "call gapping". A
second known technique is "code blocking". A "Code-
blocking" technique blocks a percentage of calls that are
routed to a specific destination code/address. In most
15 cases, a code-block control can also be specified to
include the called station's address.

On the other hand, call-gapping control, like code-block
control, limits routing to a specific code or station
20 address. Call gapping consists of an adjustable timer
that stops all calls to a specified code for a time
interval selected from, say, sixteen different time
intervals. After the expiration of the time interval,
one call to the specified code or address is allowed
25 access to the network, after which the call-gapping
procedure is re-initiated for another time interval. It
is known that call gapping is more effective than the
code-block control in controlling mass calling
situations.
30

A conceptual diagram 200 in FIG. 2 illustrates the
concepts of call gapping. Call gapping involves
automatically rejecting a percentage of the incoming call

- 5 -

attempts. The rejection process is arranged at the
ingress telephone exchange 230 to the core network 140,
to avoid route congestion. Since these automatically
failed calls never access the overloaded destination
5 point 150 in the core network 140, the signalling load at
this point, and through the core network 140, is reduced.

Typically, when a particular destination point 150 is
experiencing, or is anticipated to experience, an
10 excessive amount of call attempts, then call gapping is
activated for that number in all telephone exchanges 130.
The process for setting up, and modifying, a call gapping
operational status is illustrated in the flowchart 300 of
FIG. 3.
15

An Operations and Management Centre (OMC) of the wireless
communication system makes a determination as to how, and
under what conditions, to invoke call gapping. Starting
from an idle status, in step 310, the OMC (or an
20 Operator) is informed (or recognises) that an
overloaded/congested network condition exists at a
particular network node 'A'. In response to this, the
OMC invokes a call gapping process, as shown in step 320.
The OMC then sends a message to all communication
25 exchange functions (routers, gateways, etc.) to initiate
call gapping at their particular node. The call gapping
is applied for 'X%' of calls received at the
communication exchange functions and addressed to a
particular number or set of numbers, as shown in step
30 330. The OMC then returns to an idle mode, in step 360,
until the 'event' has finished.

- 6 -

Call gapping therefore causes a number of the originating
telephone exchanges to automatically fail 'X' out of 'Y'
calls made to that destination number. Thus, only (Y-X)
out of 'Y' calls actually leave the originating exchange

5   and make it to the destination exchange.

In a similar manner, the OMC (or Operator) modifies the
call gapping process when it recognises, or is informed,
that the overload/congestion situation no longer exists,

10   in step 340. When this happens, the OMC sends a message
to all of the exchanges to modify their call gapping
processes for destination node 'A', in step 350, and
returns to an idle mode of operation, in step 360.

15   The operation at the exchange is illustrated in the
flowchart 400 of FIG. 4. In this regard, the exchange is
woken up from an idle mode of operation in step 405, in
one of the following three ways. The exchange receives a
message from the OMC to invoke call gapping to a

20   destination node, a particular telephone number or a set
of numbers and block 'X%' of calls, in step 410. The
exchange will then update its call gapping list for the
destination node(s)/number(s) with the rule to block 'X%'
of calls, in step 415. The exchange will then return to

25   an idle mode of operation, whilst performing call
gapping, in step 455.

Following the exchange invoking a call gapping mode of
operation, the exchange may be woken from an idle mode of

30   operation, in step 405, when it receives a call attempt
to the partially blocked destination node 'A', as shown
in step 430. If the exchange determines that the
intended destination of the call is not in the call

- 7 -

gapping list in the normal manner, as shown in step 435,
the exchange sets up the call in step 445 and returns to
an idle mode of operation in step 455. If, however, the
exchange determines that the intended destination of the
5   call is in the call gapping list in step 435, the
exchange will, for example, invoke call gapping. In this
regard, call gapping allows one connection request for a
controlled code or set of codes to be accepted into the
network, by each node. This connection is allowed once
10   every 'x' seconds. Any connection requests arriving
after the accepted connection request are rejected for
the next 'y' seconds. In this manner, call gapping
effectively limits the number of successful connection
requests and prevents the overload of the network to a
15   particular focal point, as shown in step 440.

If the exchange determines that the value of the random
number generated is above the requested blocking
percentage value, the exchange sets up the call to
20   destination 'A' in step 445 and returns to an idle mode
of operation in step 455. If, however, the exchange
determines that the value of the random number generated
is at or below the requested blocking percentage value,
the exchange does not set up the call to destination 'A'
25   in step 445. The exchange then returns a "network busy"
message to the originating caller and returns itself to
an idle mode of operation in step 455.

Thus, call gapping is effective for a fixed network.
30   However, a call gapping technique is much less effective
when utilised in a mobile network employing a shared air-
interface, such as a GSM cellular communication system.

- 8 -

US patent no.5548533,, titled "Overload control for a
central processor in the switching network of a mobile
communications system", describes a network overload
control mechanism for a central processor in a switching
5   network of a mobile radio system. The central processor
may be part of a Mobile Switching Centre (MSC). In US
5548533, congestion reports that are based on the delay
experienced by messages waiting processing at the central
processor are broadcast to peripheral processors. The
10 peripheral processors are located in the MSC at
interfaces of the MSC to other network elements such as
base transceiver stations (BTSs), the PSTN, or other
MSCs. Therefore, the MSC is configured to reject a
number of call attempts received from wireless subscriber
15 units. .

However, a large amount of call attempts from mobile
users, which effectively have little or no chance of
success, still consume valuable and scarce radio
20 resource. In particular, extraordinary events, for
example road accidents, can cause excessive mobile calls
being made in a particular area, which creates
communication problems for all mobile users in that area.

25 Thus, there exists a need in the field of the present
invention to provide a communication system and a method
for congestion relief in network overload situations,
wherein the aforementioned disadvantages may be
alleviated.
30
Statement of Invention

- 9 -

In accordance with a first aspect of the present invention, there is provided a wireless communication system, as claimed in Claim 1.

5   In accordance with a second aspect of the present invention, there is provided a communication unit, as claimed in Claim 8.

In accordance with a third aspect of the present
10   invention, there is provided a method of congestion relief, as claimed in Claim 13.

In accordance with a fourth aspect of the present invention, there is provided a storage medium, as claimed
15   in Claim 18.

In summary, the inventive concepts of the present invention alleviate the problems associated with prior art by moving the call gapping mechanism down into the
20   wireless subscriber units, to minimise wasted use of the air-interface as well as communication links from serving communication units to originating exchanges.

Hence, moving the call gapping function into the wireless
25   subscriber units prevents the calls, which cannot be handled by the destination node or exchange, from ever being originated. This prevents wasteful congestion on any parts of the network. Preferably, the call gapping parameters are broadcast to cell sites to communicate
30   thereon to all subscriber units.

- 10 -

Brief Description of the Drawings

FIG. 1 shows a conceptual diagram of a cellular radio communications system indicating a large number of calls
5 being routed to an overloaded destination node/number;

FIG. 2 shows a conceptual diagram of a cellular radio communications system indicating a large number of calls being routed to an overloaded destination node/number,
10 when call gapping is employed;

FIG. 3 illustrates a flowchart of a call gapping mechanism for an OMC; and

15 FIG. 4 illustrates a flowchart of a call gapping mechanism as implemented at an originating exchange.

Exemplary embodiments of the present invention will now be described, with reference to the accompanying
20 drawings, in which:

FIG. 5 shows a block diagram of a cellular radio communications system adapted to support the various inventive concepts of a preferred embodiment of the
25 present invention;

FIG. 6 shows a conceptual diagram of a communication system indicating call gapping as it is employed in a preferred embodiment of the present invention;
30

FIG. 7 illustrates a flowchart of a call gapping mechanism for an OMC adapted to support the various

inventive concepts of a preferred embodiment of the
present invention;

FIG. 8 illustrates a flowchart of a call gapping
5   mechanism for a BSS adapted to support the various
inventive concepts of a preferred embodiment of the
present invention;

FIG. 9 illustrates a flowchart of a call gapping
10   mechanism for a MS adapted to support the various
inventive concepts of a preferred embodiment of the
present invention; and

FIG. 10 illustrates a wireless communication unit adapted
15   in accordance with a preferred embodiment of the present
invention.

Description of Preferred Embodiments

20   Referring first to FIG. 5, a cellular telephone
communication system 500 is shown, in outline,
supporting, for example, a Global System for Mobile
communication (GSM) air-interface, in accordance with a
preferred embodiment of the invention. The European
25   Telecommunications Standards Institute (ETSI) has
standardised the air-interface for the Global System for
Mobile communication (GSM).

Generally, the air-interface protocols are administered
30   from base transceiver sites, within the network
architecture 510, which are geographically spaced apart -
one base station supporting a cell (or, for example,
sectors of a cell). A plurality of subscriber units

- 12 -

hereinafter referred to as mobile stations (MSs) 512-516
communicate over the selected air-interface 518-520 with
a plurality of base transceiver stations (BTS) 522-532.
A limited number of MSs 512-516 and BTSs 522-532 are
5   shown for clarity purposes only. The BTSs 522-532 may be
connected to a conventional public-switched telephone
network (PSTN) 534 through base station controllers
(BSCs) 536-540 and mobile switching centres (MSCs) 542-
544.
10

Each BTS 522-532 is principally designed to serve its
primary cell, with each BTS 522-532 containing one or
more transceiver units and communicating 556-566 with the
rest of the cellular system infrastructure
15

Each Base Station Controller (BSC) 536-540 may control
one or more BTSs 522-532, with BSCs 536-540 generally
interconnected through MSCs 542-544. A BTS-BSC
combination is generally referred to as a Base Switching
20   Site (BSS). Each MSC 542-544 provides a gateway to the
PSTN 534, with MSCs 542-544 interconnected through an
operations and management centre (OMC) 546 that
administers general control of the cellular telephone
communication system 500, as will be understood by those
25   skilled in the art.

The various system elements, such as BSCs 536-538 and OMC
546, include control logic 548, 550, 552, with the
various system elements usually having an associated
30   memory function 554 (shown only in relation to BSC 538
for the sake of clarity). A memory function of the OMC
546 typically stores historically compiled operational
data as well as in-call data; call gapping blocking

- 13 -

percentages and associated destination nodes/numbers, etc.

5   FIG. 5 illustrates a GSM system overlaid with a general packet radio system (GPRS) air-interface, to provide a packet data capability. In this manner, a number of packet data-capable subscriber units such as MS 512 are able to communicate via circuit-switched (CS) calls on the GSM network and packet data calls on the GPRS

10   network. The GPRS network comprises a number of packet control units (PCUs) 570, 580 operably coupled to service GPRS support nodes (SGSNs) 572, 582 to facilitate communication from the MSs to packet data networks such as the Internet 534. The SGSNs 572, 582 (with only two

15   being shown for clarity purposes only) are operably coupled to the GSM BSCs 536-538. The SGSNs are operably coupled to external packet data networks via GPRS gateway support nodes GGSNs 574, 584.

20   In accordance with the preferred embodiment of the present invention, the call gapping process typically implemented by the OMC and MSCs have been extended to the air-interface communication units, i.e. the BTS and MS. In particular, the air-interface communication units are

25   adapted to invoke call gapping, rather than the originating exchange, thereby preventing wasteful use of the radio resource by blocking call attempts at source. A conceptual diagram of the modification to the call routing is illustrated in FIG. 6. The adaptation of the

30   OMC, BTS and MS operations are illustrated in flowcharts of FIG. 7 to FIG. 9.

- 14 -

In general, it is envisaged that the change in call gapping operations in the OMC 546, BTS 522 and MS 512, as programmed according to the preferred embodiment of the present invention, may be implemented in a respective
5   communication unit in any suitable manner. For example, new apparatus may be added to a conventional BTS 522 or MS 512, or alternatively existing parts of a conventional BTS 522 or MS 512 may be adapted, for example by reprogramming one or more processors therein. As such
10   the required adaptation may be implemented in the form of processor-implementable instructions stored on a storage medium, such as a floppy disk, hard disk, programmable read only memory (PROM), random access memory (RAM) or any combination of these or other storage media.
15

Referring now to FIG. 6, a conceptual diagram of a cellular radio communications system 600 is illustrated, wherein the diagram indicates call gapping as it is employed in a preferred embodiment of the present
20   invention. A particular destination node/telephone number 150 is identified as experiencing, or is anticipated to experience, an excessive amount of call attempts. Hence, call gapping is invoked for that particular destination node/telephone number 150 by, say,
25   an OMC operably coupled to the core network 140.

In accordance with the preferred embodiment of the present invention, the OMC instructs the BSS (BSC and BTS) and respective MSs served by the BSSs to initiate a
30   MS-based call gapping process. In this manner, a limited number of wireless subscriber units 610 attempt to contact the particular destination node/telephone number 'X' 160. The MSs are configured to perform a self-

- 15 -

regulating call gapping process; in order to limit the
generation and transmission of air-interface based
communications. The self-regulating process ensures that
only a given percentage of calls are made, with some MSs
5   610 successful in the self-regulating process and others,
such as MSs 612 unsuccessful. The preferred mechanism to
determine which MSs are successful is described later.

Hence, the air-interface resource is significantly less
10 utilised in carrying such wireless transmissions 615 to
the subscriber unit's respective BSSs 620.
Advantageously, the fixed network connections 625 between
the wireless BTSs and the wireless exchange 130 are also
significantly less utilised in carrying such
15 transmissions. The calls that are generated are then
transmitted over the air-interface and routed through the
core network 140 to a destination exchange 150. However,
notably there are much fewer calls reaching the
originating exchange 130.
20

Fewer incoming calls are rejected by the destination
exchange 150. In this manner, a large number of
communication paths/routes are optimally utilised and
avoid becoming congested, with many fewer attempted calls
25 being carried on these communication paths/routes
failing.

The process for setting up, and modifying, a call gapping
operation in an OMC, in accordance with the preferred
30 embodiment of the present invention, is illustrated in
the flowchart 700 of FIG. 7. An Operations and
Management Centre (OMC) of the wireless communication
system, say OMC 546 of FIG. 5, makes a determination as

- 16 -

to how, and under what conditions, to invoke call
gapping. Starting from an idle status, in step 710, the
OMC (or an Operator) is informed (or recognises) that an
overloaded network condition exists at a particular
5   network node 'A'. In response to this, the OMC invokes a
call gapping process, as shown in step 720. The OMC then
sends a message to all communication exchange functions
(routers, gateways, etc.) to initiate a call gapping
process at all MSs supported by that particular exchange.
10

In the preferred embodiment of the present invention, the
message is sent to the MSs on the broadcast channels of
the affected cells. Preferably, the message contains one
or more of the following items of information, to enable
15   the MSs to perform self-regulated call gapping:

        (i) A telephone number of the overloaded
exchange, for which the call gapping mechanism is to
apply;
20   (ii) A set or range of telephone numbers of the
overloaded exchange, for which the call gapping mechanism
is to apply;
              (iii) A percentage number of calls that may be
allowed to progress from the MS; and/or
25   (iv) A time duration for the call gapping
mechanism to remain active.

In an enhanced embodiment of the present invention, more
than one number range may be included in the broadcast
30   message. For example, it is envisaged that a first
general restriction may be applied to all numbers used
that are associated with the overloaded network.
Application of this first range provides, for example, a

- 17 -

10% call attempt rate to be used. It is envisaged that a
second range may also be used, for example where the
second range is specific to emergency numbers. The
second range may therefore allow 100% of these calls to
5   pass. A skilled artisan would appreciate that many
alternative applications may use two or more blocking
percentage values.

Furthermore, it is within the contemplation of the
10 present invention that the aforementioned inventive
concepts may be applied to call gapping using any one or
more destination address.(es). Thus, the inventive
concepts can be applied to a single number, a list of
numbers, a range of numbers (e.g. to a portion of the
15 addresses in a particular exchange code), several ranges
of numbers, etc.

Referring back to FIG. 7, in response to the message from
the OMC, the MSs are directed to initiate call gapping of
20 'X%' of calls addressed to a particular number or set of
numbers, as shown in step 730. The OMC then returns to
an idle mode, in step 760, until the 'event' has
finished.

25 The call gapping process of the preferred embodiment
therefore causes the originating an automatic reduction
of 'X' out of 'Y' air-interface calls that would have
been intended for that destination number. Thus, only
(Y-X) out of 'Y' calls are actually sent from a wireless
30 MS to its serving BTS/BSS, and ultimately onto the
destination exchange via the originating exchange.

- 18 -

In a similar manner, the OMC (or Operator) modifies the call gapping process when it recognises that, or is informed that, the network overload/congestion situation no longer exists, as shown in step 740. When this
5   happens, the OMC sends a message to all of the exchanges to modify the MS self-regulating call gapping process, in step 750, and returns to an idle mode of operation, in step 760.

10 It is envisaged that the terminology of 'modifying' a call blocking process, indicates that the call blocking list has been modified (e.g. an address list may have been changed), or ended (e.g. an address list is now empty).
15

In the preferred embodiment of the present invention, a call gapping process is in place, whereby some of the wireless calls (as perceived by the MS user) will succeed. Similarly, some attempted wireless calls will
20 receive a "Network Busy" notification. However, advantageously, the inventive concepts described herein ensure that the call gapping process is implemented *prior to any call attempts being launched into the telecommunications network. Thus, the filtering of calls*
25 is performed at source, i.e. inside the originating terminal.

Notably, the call gapping process is invoked in accordance with information supplied by the network.
30 Referring now to FIG. 8, a flowchart 800 of the preferred call gapping mechanism of the BSS is shown, in accordance with the preferred embodiment of the present invention.

- 19 -

A Base switching site (BSS) of the wireless communication
system, say BTS 532 and BSC 536 (forming a base switching
site of FIG. 5), receives an instruction from an OMC to
invoke a call gapping process. Starting from an idle

5 status, in step 805, the BSS is informed of an
overloaded/ congested network condition at, say, a
particular telephone number(s) or network node 'A'. The
BSS is informed that it needs to initiate a call gapping
process, blocking 'X%' of calls to the telephone

10 number(s) or network node 'A', as shown in step 810. In
response to this, the BSS updates its call gapping list,
as shown in step 815. The BSS then preferably broadcasts
a message to all MSs supported by BSS, in step 820. The
BSS then returns to an idle mode of operation, in step

15 840. In contrast to broadcasting a call gapping message
to all supported MSs, it is envisaged that such messages
may be sent to particular groups of MSs or individual
MSs, in some instances, if they are identified as one or
more MSs that should employ a self-regulating call

20 gapping process.

Advantageously, the preferred embodiment of the present
invention may use messaging capabilities such as short
message service (SMS) messages to broadcast/communicate

25 the call gapping requirements to all or a select number
of MSs. This approach can be used to target specific
users, or groups of users, where:

      (i) Certain users are recognised as very heavy
users and may be call gapped more frequently;

30   (ii) There is a 'Denial of Service' attack
(possibly not malicious), which the Operator wants to
reduce. This can be caused by erroneous auto-redial
systems.

- 20 -

(iii) Some users receive a different grade of
service (GoS) to others, and thus endure a different
level of call gapping severity.

5   In a similar manner, the BSS modifies the call gapping
process when it receives instructions from the OMC to do
so, in step 825. When this happens, the BSS again
updates its call gapping list by removing the entry for
the particular telephone number(s) or destination node
10   'A', in step 830. The BSS then broadcasts a modify call
blocking message to all of the supported MS, in step 835,
and returns to an idle mode of operation, in step 840.

From a MS perspective, in the preferred embodiment of the
15   present invention, the decision on whether to continue or
reject a call attempt is performed internally. A skilled
artisan will recognise that there are a number of
mechanisms for the MS to make a decision on whether to
make a requested call. A preferred mechanism is for the
20   MS to generate a random test number and compare this
number against the probability value received from the
network. This process is described in the flowchart 900
of FIG. 9.

25   A MS starts in an idle mode of operation, as shown in
step 905. The MS receives a broadcast message from its
serving BSS to initiate a call gapping process, say to
node 'A', in step 910. Preferably, the broadcast message
includes a percentage of calls to be blocked.
30   Furthermore, the broadcast message also preferably
includes a time-out value 'T'. In response to receiving
the broadcast message, the MS updates its call gapping

- 21 -

list for destination 'A', in step 915 and initiates a
timer operation in step 920.

The MS then returns to an idle mode of operation (apart
5   from operating the timer), with regard to the call
gapping process, in step 970. If the timer 'T1' expires,
in step 940, it is anticipated that the 'event' has
finished. The MS also understands the 'event' to have
finished when it receives a broadcast 'modify call
10   gapping message' from its serving BSS, in step 925. In
response to either of these, the MS updates its call
gapping list, by removing the entry for destination 'A',
in step 930. The timer is then stopped in step 935,
before the MS returns to an idle mode of operation, in
15   step 970.

If, whilst the call gapping process is active for a
particular destination, a user attempts to make a call to
the destination 'A', in step 945, the MS determines
20   whether the called number is in the call gapping list, as
shown in step 950. If the called number is not in the
call gapping list, in step 950, the MS sets up a call, in
step 960. However, if the MS determines that the called
number is in the call gapping list, in step 950, a
25   determination is made as to whether the called number
should be blocked, in step 955. In this regard, the MS
preferably uses a random number generator to generate,
say, a value between '0' and '1'. This value is then
compared to the blocking percentage informed by the BSS.
30   If the value exceeds the blocking percentage, the MS sets
up the call as normal, in step 960. However, if this
test fails, the MS returns a 'network busy' indication to
the user, in step 965, before returning to an idle mode

- 22 -

of operation, in step 970. This approach takes advantage
of the intelligence of cellular terminals to
intelligently manage the usage of the scarce radio
resources.

Although the preferred embodiment of the present
invention has been described with reference to
implementing a call gapping process using a random number
generator arrangement, it is envisaged that any number of
mechanisms could be used to implement the call attempt
pass/fail decision. For example, possible mechanisms
include:

     (i) Using a random number generator, as
described;

     (ii) An MS computes a pass/fail time window; and

     (iii) The network indicates the valid and/or
invalid time windows as a signal (e.g. using a flag) in
the call gapping broadcast messages. In this case the
pass/fail opportunities are common to all mobiles in a
cell.

When a MS receives the broadcast message, the MS stores
and activates these restrictions, preferably for the time
period indicated in this message. If this message is
received again, the elapsed timer is reset to zero and
starts again. Thus, it is envisaged that the network
must regularly broadcast these restrictions within the
expiry time period, otherwise the restrictions will be
automatically removed within the MS.

It is within the contemplation of the present invention
that a variety of scenarios may invoke the call gapping
process hereinbefore described. For example, where a

- 23 -

cell is overloaded or congested, perhaps following an
accident in a particular geographical region, call
gapping may be applied to any number of cell sites in
that region. In this manner, the geographically selected
5 call gapping process may reduce the ability of MSs to
make normal calls by, say, a first percentage, and reduce
a number of calls to, say, special numbers by a second
another percentage. In this context, special numbers may
comprise, for example, internal emergency service
10 numbers.

Referring now to FIG. 10, there is shown a block diagram
of a wireless communication unit, for example a GSM phone
(MS) 1000, which is adapted to support the inventive
15 concepts of the preferred embodiments of the present
invention. As known in the art, and replicated here for
completeness, the MS 1000 comprises, for example,
standard radio frequency components and circuits, such as
an antenna 1002 preferably coupled to an antenna switch
20 1004. The antenna switch 1004 provides isolation between
a receiver and a transmitter chain within the MS 1000.
The receiver chain typically includes receiver front-end
circuitry 1006 (effectively providing reception,
filtering and intermediate or base-band frequency
25 conversion). The front-end circuitry 1006 is serially
coupled to a signal processing function 1008. In
accordance with the preferred embodiment of the present
invention, the MS 1000 receives, interprets and adapts
its operation in response to a call gapping broadcast
30 message from the network.

In addition to processing and implementing a call gapping
broadcast message, as described above with reference to

- 24 -

the flowchart 900 of FIG. 9, the signal processing
function 1008 performs all signal processing functions
for the MS 1000, including, for example, demodulation,
de-mapping, bit de-interleaving channel estimation and
5   decoding, as known in the art.

For completeness, the receiver chain also includes
received signal strength indicator (RSSI) circuitry 1012
coupled to the receiver front-end circuitry 1006 and the
10   signal processing function 1008 (generally realised by a
digital signal processor (DSP)). A controller 1014, also
coupled to the receiver front-end circuitry 1006 and the
signal processing function 1008, may therefore receive
bit error rate (BER) or frame error rate (FER) data from
15   recovered information. The controller 1014 is coupled to
the memory device 1016 for storing operating regimes,
such as decoding/encoding functions and the like. In
accordance with the preferred embodiment of the present
invention, the memory device stores a call gapping list
20   of one or more telephone numbers or destination nodes or
addresses, together with blocking percentage(s), where a
call gapping process applies.

A timer 1018 is coupled to the controller 1014 to control
25   the timing of operations (transmission or reception of
time-dependent signals) within the MS 1000. In the
context of the present invention, the timer 1018 has been
adapted to enable the MS to self-regulate instructed call
gapping processes for a pre-defined (or instructed)
30   period of time.

As regards the transmit chain, as also known in the art,
this essentially includes an input device, such as a

- 25 -

microphone transducer coupled in series via transmit
signal processor 1008 to a transmitter/ modulation
circuit 1022. Thereafter, any transmit signal is passed
through a power amplifier 1024 to be radiated from the
5   antenna 1002. The transmitter/ modulation circuitry 1022
and the power amplifier 1024 are operationally responsive
to the controller, with an output from the power
amplifier coupled to the duplex filter or circulator
1004. The transmitter/ modulation circuitry 1022 and
10 receiver front-end circuitry 1006 comprise frequency up-
conversion and frequency down-conversion functions (not
shown).

In accordance with the preferred embodiment of the
15 present invention, the signal processor 1008 has been
adapted to intercept any call attempt from the user that
uses the one or more telephone numbers or destination
nodes or addresses stored in the call gapping list. If
the MS 1000 determined that an intercepted call attempt
20 by the user contains one or more telephone numbers or
destination nodes or addresses from the stored call
gapping list, the signal processor 1008 decides whether
to accept or reject the call request.

25 The signal processor 1008 has been further adapted to
include (or be operably coupled to) a random number
generator. The random number generator is preferably
invoked when a user attempts to call a partially blocked
(call gapping) address/number/node. If, for example
30 after comparing a random number generated with a blocking
percentage received in a broadcast message and stored in
the memory device, the signal processor 1008 determined
that a call is allowed, the MS 1000 processes the call in

- 26 -

the normal manner. Otherwise, the MS 1000 preferably
sends a 'network busy' message to the display of the MS
1000 and does not thereafter generate a wireless
transmission.

5

Of course, the various components within the MS 1000 can
be arranged in any suitable functional topology that is
able to utilise the inventive concepts of the present
invention. Furthermore, the various components within

10   the MS 1000 can be realised in discrete or integrated
component form, with an ultimate structure therefore
being selected based on the MS designer.

In contrast to a random number generated approach, it is
15   envisaged that an alternative mechanism to implement call
gapping may be to count out a number of successful call
attempts, followed by a number of unsuccessful attempts
(i.e. set an integer OK/Fail ratio).

20   With the evolution towards third (and beyond) generation
cellular communication units, the wireless subscriber
units (MSs) are becoming ever more complex and
proficient. For example, it is envisaged that the
inventive concepts described herein are ideally suited to
25   a Mobile Execution Environment (MExE) application,
whereby the functionality to perform such MS call gapping
is downloaded over-the-air into the MS (perhaps written
in Java™).

30   In the preferred embodiment of the present invention, it
is envisaged that a list of destination numbers, each
with blocking probability associated with it may be
broadcast from the network. In this regard, it is

- 27 -

envisaged that each entry could be a complete number.
Alternatively, the destination nodes/numbers may be based
on wildcards, which indicate one or more numbers that are
ignored when performing the comparison against the user-
5   input address.

Although the invention has been described with reference
to a speech communication air-interface such as GSM, it
is within the contemplation of the invention that the
10 inventive concepts herein described are equally
applicable to any wireless communication system. It is
also envisaged that, when applied to a GPRS (or other
packet data communication system such as a Universal
Mobile Telecommunication System (UMTS)), that the use of
15 alternative addressing mechanisms could benefit from the
inventive concepts described herein. For example, IP
addresses, cr domain name server (DNS) addresses could. be
used in a data-networking scenario.

20 Although the preferred embodiment of the present
invention has been described with reference to
implementation in a wireless communication unit capable
of functioning in a GSM, GPRS, UMTS, IS-95 or CDMA2000
wireless communication system, it is envisaged that the
25 inventive concepts can be applied in a fixed
· communication unit, such as a Personal computer employing
voice over Internet Protocol. It is also within the
contemplation .of the invention that the call gapping
process can be applied to control other procedures.   For
30 example, the inventive concepts could be applied to any
data connections by, say, gapping PDP context activation
requests (to reduce signalling load), attaches, mobility
management procedures, etc.

- 28 -

It will be understood that the wireless communication
system, wireless communication unit and method for
congestion relief, as described above, tends to provide
5   at least one or more of the following advantages:

     (i) Congestion relief using a call gapping
technique can be extended to minimise air-interface
traffic in a wireless communication environment to
prevent calls being initiated that would ultimately
10   result in an unconnected call.

     (ii) The proposed congestion relief mechanism
reduces needless traffic between a BSS and a local
(originating) exchange, thereby making that resource
available for communications that have a chance of being
15   successful.

     (iii) The inventive concepts can be applied to
any address-based scenario.

     (iv) Specific call gapping targeted to mobiles. to
control, say, a 'Denial of Service' attack.
20

Whilst specific, and preferred, implementations of the
present invention are described above, it is clear that
one skilled in the art could readily apply variations and
modifications of such inventive concepts.
25

Thus, a wireless communication system, a wireless
communication unit and a method for reducing congestion
have been provided, wherein the aforementioned
disadvantages associated with prior art arrangements have
30   been substantially alleviated.